Space Weather Technical Forecast

Issued on Tuesday, 18 April 2023 at 01:13 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Chance of M-class flares (R1-R2 Minor-Moderate radio blackouts), and a slight chance of X-Class flares (R3 strong radio blackouts) throughout. Chance of G1/Minor Storms 19-20 Apr with a slight chance of G2/Moderate or G3/Strong Storms on the 20 Apr due to possible CME arrival.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low through the last 24 hours, with two notable C-class flares. The first was a C7.0 flare observed from AR3281 at 17/0633UTC and the second at 17/1431UTC from AR3283 which reached C6.9. There are nine sunspot regions on the visible disc, with seven of these presenting various levels of a β magnetic configuration. The largest region is AR3282 near centre disc has evolved slowly over the last 24 hours and a Fki Zurich classification. AR3280, about to imminently rotate across the southwest limb is becoming difficult to analyse due to the location. AR3279 and AR3281 are also relatively complex but stable and appear to be interacting magnetically. AR3283 to the southeast of the aforementioned regions is also of note. No Earth-directed CME have been observed on available imagery in the last 24 hours, although imagery is being awaited for ongoing analysis.

Solar Wind / Geomagnetic Activity: The solar wind observed at L1 started at slow-ambient levels before a steady enhancement from 17/0900UTC, tallied with a dip in density, suggesting a weak coronal hole high speed stream connection, possibly due to either coronal holes 92 or 93. Total magnetic field, IMF, was weak throughout much of the period, with moderate levels occasionally reached. The north-south component has varied weakly through much of the period, but rotated sharply southwards after 17/1130UTC, to reach -8nT. The phi angle was generally positive (towards the Sun) or near neutral. Geomagnetic activity was Quiet.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) as measured at GOES16, was at background levels. High energy electron flux (greater than 2MeV) as measured at GOES16 was at background levels. The associated 24-hour integrated electron fluence was well below the Active threshold on a steady trend, with 1.35e6 integrated pfu observed at 18/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is expected to be Low, with a likelihood of Moderate activity, mainly due to AR3282 or AR3280, especially for days 1 and 2 (18 and 19 April) with respect to the second region. There is also a chance for significant activity from two regions beyond the eastern limb, which are forecast to rotate onto the visible disc.

Solar Wind / Geomagnetic Activity: Two CMEs are anticipated to affect the Earth in this period. One, as a low confidence glancing blow on 19 Apr, with a further more direct near full halo on 20 Apr. Otherwise solar winds are expected to remain mainly at background, with an initial period at slightly elevated levels for the first 24 hours as a result of weak coronal hole high

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speed streams from coronal holes 92 or 93. A further coronal hole high speed stream is possible late on 20 Apr, but this may be masked by the forecast CME arrival. Geomagnetic activity is forecast to be Quiet to Unsettled, with a chance of G1/Minor Storm intervals on 19 and 20 Apr. There is also a risk of G2/Moderate or G3/Strong storms on 20 Apr depending on the strength of the CME arrival.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at background levels, although there is a slight chance of a greater than S1 event as some of the more complex active regions transit towards the western solar hemisphere. High energy (greater than 2 MeV) electron flux is currently at background levels with little change probable throughout much of the period. The associated 24-hour integrated fluence is expected to remain below the Active threshold (1e8 integrated pfu).

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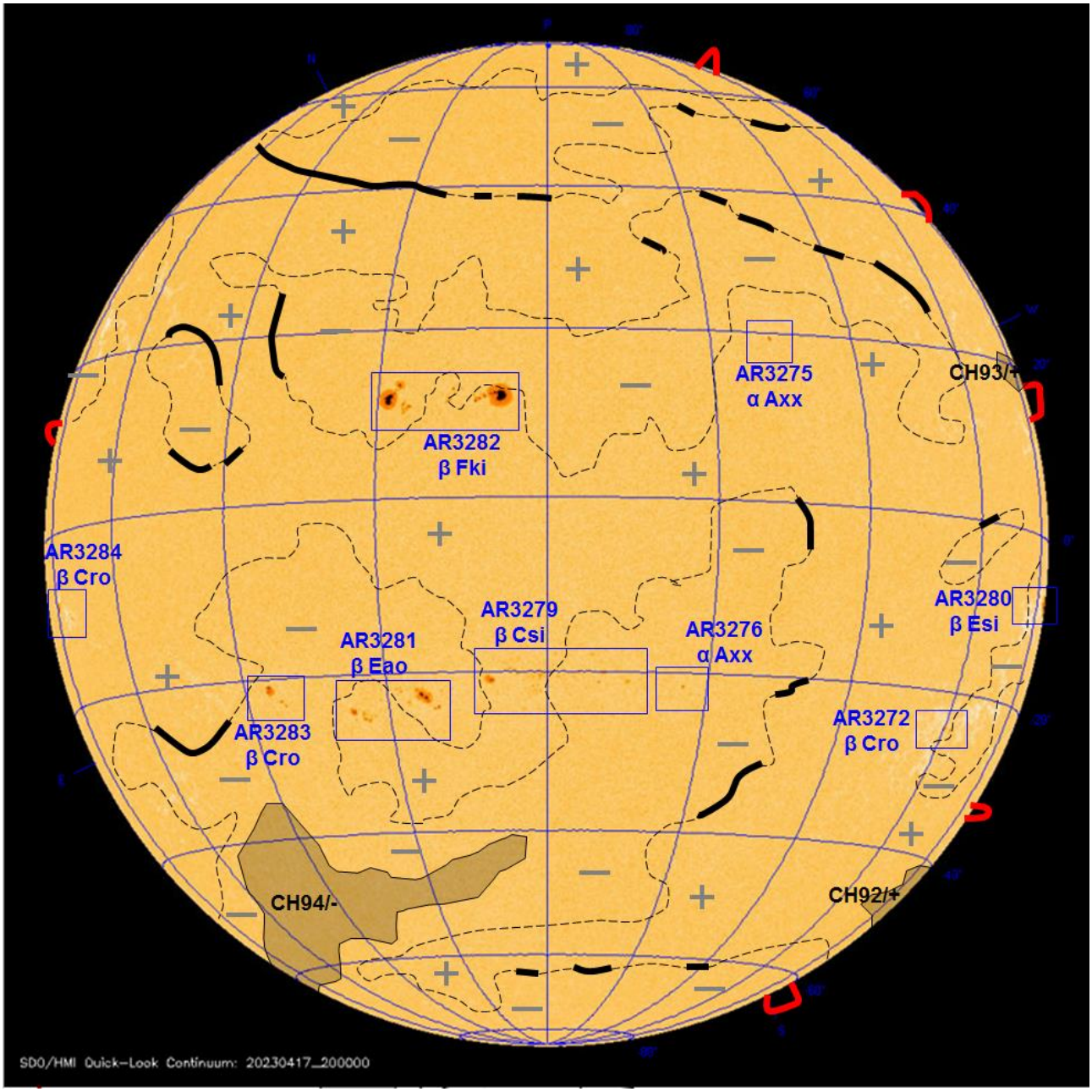
Figure 1. Solar Analysis Valid 2000UTC, 17 April 2023.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A couple of CMEs have been analysed and are predicted to have an Earth-directed component through this forecast period. The first, a filament eruption at around 15/1100UTC is forecast to potentially glance the Earth during 19 Apr. A CME halo from an eruption later that same day that occurred at 15/2324UTC is then forecast to arrive at Earth during 20 Apr, perhaps into 21 Apr. There is moderate confidence in the forecast for this eruption, with several analysis returning similar numbers. However the Enlil ensemble is currently giving a large temporal spread centred on 20/1800UTC.

A relatively modest high speed stream appears to have connected with Earth from around 17/1100UTC, which may be a weak connection to either coronal holes 92 or 93. Solar winds are currently around 440km/s on a shallow rising trend. This connection should subside over the next 24 hours. The CME forecast is potentially contaminated by a high speed stream from a coronal hole which could connect with the Earth from later on day 3 (20 April), although given the high southern latitude of the feature, any connection carries rather low confidence.

Geomagnetic activity is forecast to be Quiet to Unsettled through 17 to 19 Apr. There is then a chance of Active or G1/Minor storm intervals due to the glancing CME on 19 Apr. Further Active intervals are then likely on 20 Apr due to the CME arrival, with a chance of G1/Minor Storm intervals. The feature is currently modelled to be moving at 300-400km/s, with a slight chance of this stage of G2/Moderate or G3/Strong Storms.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	20	40	20
Strong	G3	No	1	1	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/0550	Partial halo	Filament eruption	NW	250 km/s	19/1200UTC	Low confidence
16/1343	Partial halo	Filament eruption	NW	350 km/s	20/1800UTC	Possible G2 or G3 storms

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Figure 2: MOSWOC Enlil showing possible arrival time of near full halo CME.

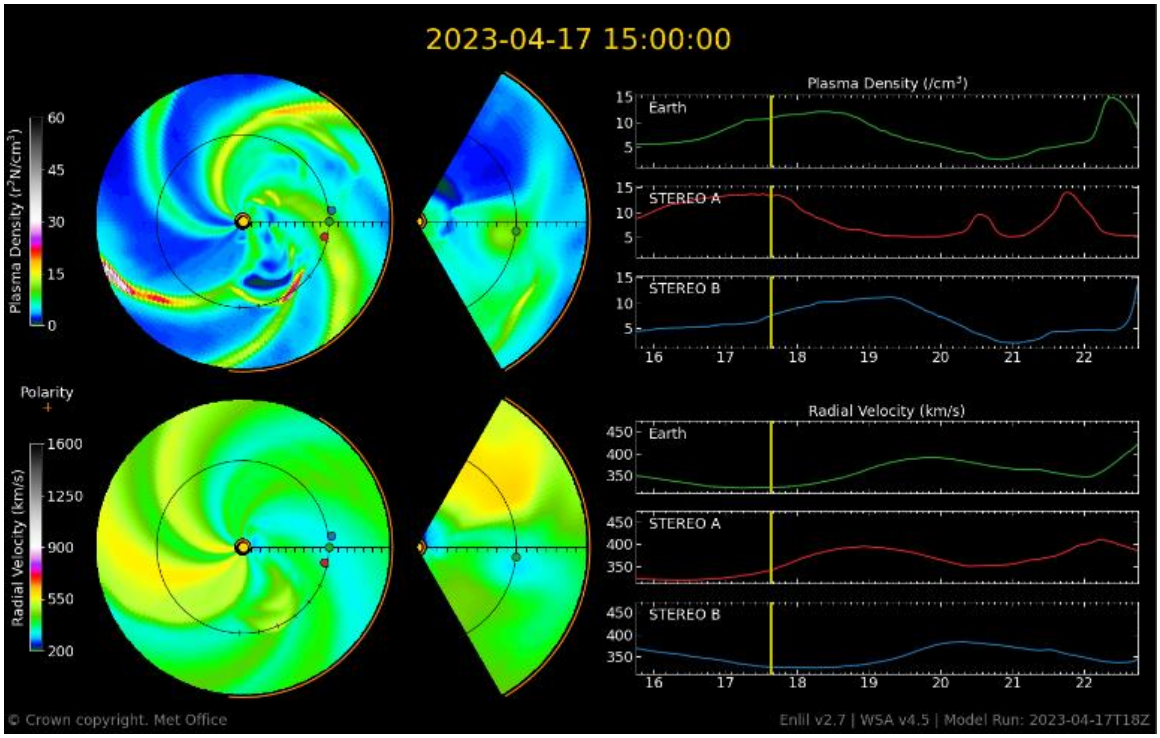
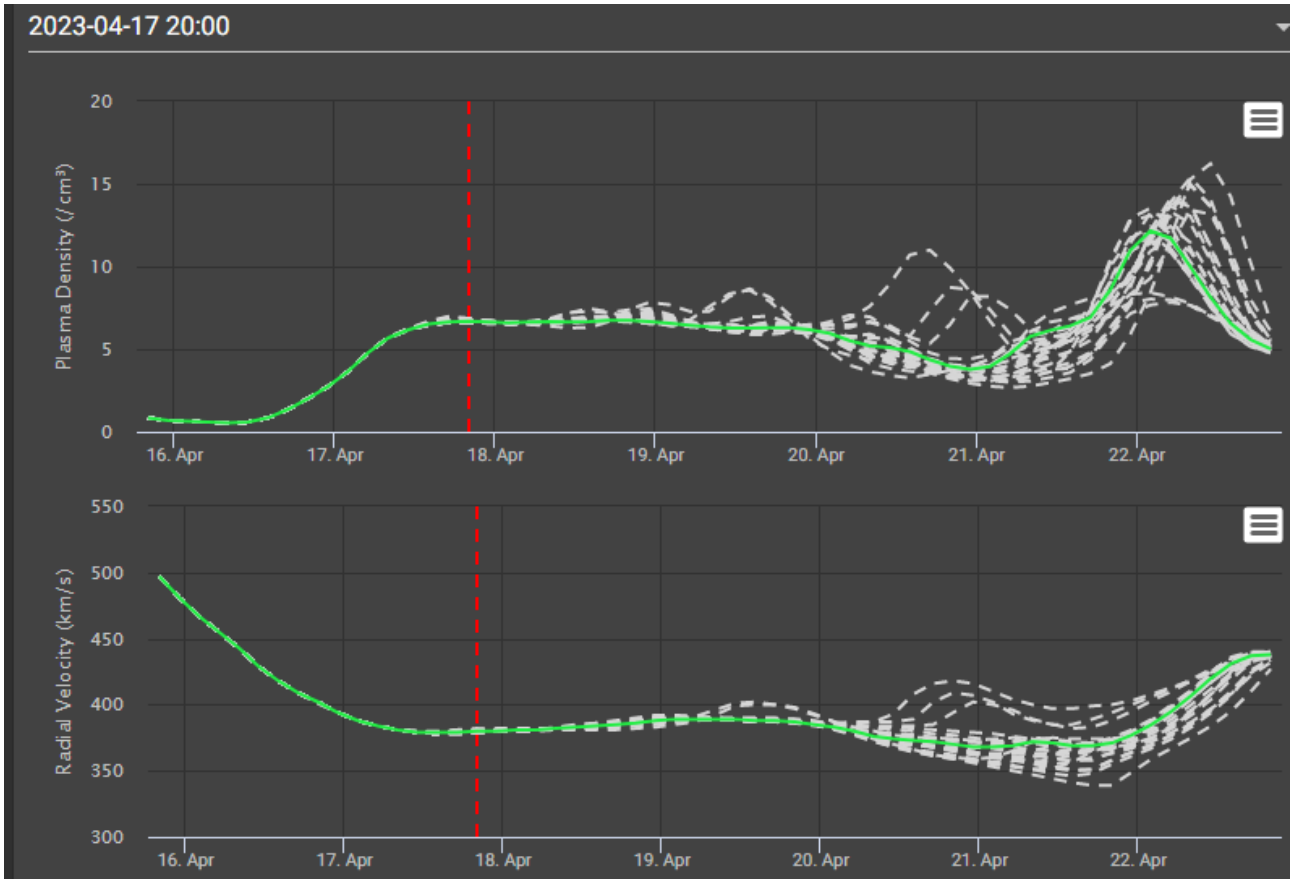


Figure 3: MOSWOC Enlil ensemble, showing the range of potential arrival times across the ensemble members for the 20 Apr CME, demonstrating moderate uncertainty in the arrival time.



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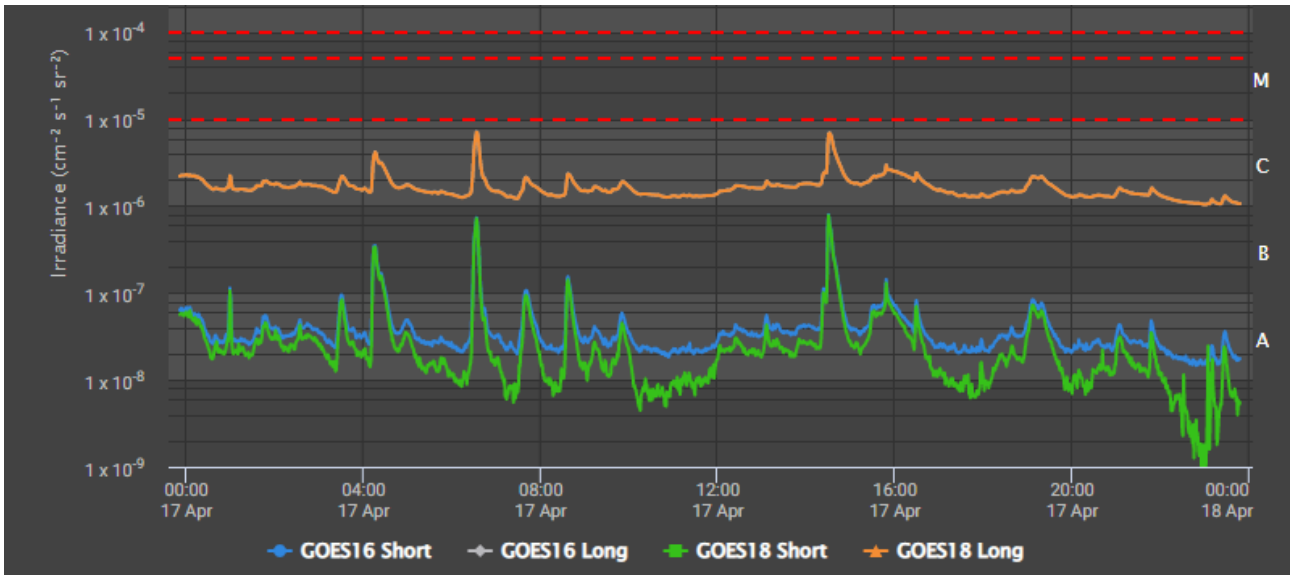
Radio Blackouts - X-Ray Flares:
There are nine active regions on the visible disc, AR3282 is the largest and most prominent region as it approaches centre disc. AR3280 is the second largest and is about to rotate across the southwest limb. AR3281 has changed little in recent hours with after a pattern of growth and decay. A new region is rotating onto the southeast limb, associated with a bright area of flux, and has just been numbered AR3284. The remaining regions are all stable or benign. AR3280 also presents a risk of significant flare activity, especially due to its current location, where it could produce geoeffective proton storming from energetic storms. None of the regions have a recent history of significant activity, which is reflected on risks below those suggested by raw risk probabilities for the various configurations. Two new regions beyond the northeast and southeast limb respectively appear bright of SDO AIA 94 imagery and could reveal significant complexity as they rotate onto the visible disc. The northeast limb region already has a history of a relatively large flare, producing a C9.0 with some of this occulted by the solar limb. Low solar activity is predicted with a likelihood of M-class flares and a very slight chance of X-class flaring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	10	10	10	10

Figure 4: X-ray flux plot over the past 24 hours at GEO from GOES.



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Solar Radiation Storms - (High Energy Protons):

High energy proton flux (greater than 10MeV), as observed by GOES16, is most likely to remain at background levels through the period. AR3280 carries the greatest risk of a proton event early in the period, with a continued high level of magnetic complexity as it rotates across the western hemisphere. A number of complex regions in the east could produce some proton response from particularly energetic events, with these acting to maintain the risk through much of the guidance period as they rotate westward.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

As the solar wind is relatively muted with no significant high speed streams to feed electrons into the radiation belts, or solar wind pressure to suppress the belts into lower orbits the high energy electron flux (greater than 2MeV) has been at background and is expected to remain so for much of the forecast period. Enhanced geomagnetic activity due to forecast CME arrivals on 19 and 20 Apr could prolong this depression, with a gradual increase most likely beyond the end of the forecast period as the geomagnetic activity fades.
Electron fluence is expected to remain below the Active threshold due to the geomagnetic enhancements.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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